

Notice of Allowability

Application No.

09/990,542

Applicant(s)

NELSON, CHARLES GREGORY

Examiner

Lawrence Shrader

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to amendment filed on 8/30/2005.
2. ☒ The allowed claim(s) is/are 1 - 17, 20 - 32, 34 - 39, and 41 - 47.
3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some* c) ☐ None of the:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
- * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
- (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
- 1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
- (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|---|---|
| 1. <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 5. <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 2. <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 6. <input type="checkbox"/> Interview Summary (PTO-413),
Paper No./Mail Date _____ |
| 3. <input type="checkbox"/> Information Disclosure Statements (PTO-1449 or PTO/SB/08),
Paper No./Mail Date _____ | 7. <input type="checkbox"/> Examiner's Amendment/Comment |
| 4. <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit
of Biological Material | 8. <input checked="" type="checkbox"/> Examiner's Statement of Reasons for Allowance |
| | 9. <input type="checkbox"/> Other _____ |

DETAILED ACTION

1. Claims 1 – 17, 20 – 32, 34 – 39, and 41 – 47 are allowed; claims 18, 19, 33, and 40 had been previously cancelled.

Claim Rejections - 35 USC § 101

2. The rejections of claims 36, 39, and 44 under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter are withdrawn in view of the current amendments.

Allowable Subject Matter

3. The following is an examiner's statement of reasons for allowance:

Claim 1:

Prior art of record taken either singly and/or in combination, does not teach or disclose a method as recited in independent claim 1 with the following features:

Repeatedly invoking an automatic theorem prover for plural cycle budgets to determine a minimum cycle budget that is the lowest of any cycle budget K for which a formalized mathematical conjecture is unprovable by the automatic theorem prover; extract the near optimal code sequence from a counterexample implicit in the failed proof of the formalized mathematical conjecture for the minimum cycle budget.

Thus all remaining dependent claims 2 – 8, and 20 are also allowed.

Claim 9:

Prior art of record taken either singly and/or in combination, does not teach or disclose a method as recited in independent claim 9 with the following features:

Repeatedly invoking a theorem prover to prove unsatisfiable a formalized mathematical conjecture that, for a cycle budget K , no code sequence for the target computer architecture executes the program fragment within that cycle budget K :

If the proof fails, a K -cycled program computing the program fragment is embedded in the failed proof,

Wherein, if the near-optimal code sequence is found, and the invocation need not be repeated, when it is established that the K -cycled program computes the program fragment and a cycle budget $K-1$ is insufficient in that the cycle budget K is minimum, the K -cycled program is being extracted as the near-optimal code sequence,

*Wherein, if the near-optimal code sequence is not found in a present invocation, for a next revocation of the automatic theorem prover if the proof succeeds the budget K is doubled ($K:=K*2$); if the proof fails the proof is bisected ($K:=K/2$) and a new K -cycled program computing the fragment that is embedded in the failed proof is extracted.*

Thus all remaining dependent claims 10 – 17, and 21 are also allowed.

Claim 22:

Prior art of record taken either singly and/or in combination, does not teach or disclose a method as recited in independent claim 22 with the following features:

Applying automatic theorem-proving to a code sequence generator, including introducing a multi-assignment to the code sequence generator; based on the multi-assignment,

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producing, by the code sequence generator based on the multi-assignment, a number of possible plans for creating the near-optimal code sequence; *selecting an optimal plan from among the possible plans for automatically producing the near-optimal code sequences, wherein performing the planning with the satisfiability search is repeated a plurality of times for plural machine cycle budgets to find the optimal plan associated with a predetermined machine cycle budget.*

Thus all remaining dependent claims 23 – 32, 34, 35, and 41 are also allowed.

Claim 36:

Prior art of record taken either singly and/or in combination, does not teach or disclose a code sequence generation tool executable on a computer as recited in independent claim 36 with the following features:

An input capable of receiving a multi-assignment; a matcher responsive to the multi-assignment and producing, via matching of the multi-assignment and facts regarding operators computable in the computer, a number of possible plans for creating the near-optimal code sequence; *a planner configured to select via a satisfiability search an optimal plan from among the possible plans produced by the matcher, the optimal plan corresponding to the near-optimal code sequence; wherein the code sequence generation tool is configured to invoke the matcher and the planner thereby implementing automatic theorem-proving for automatically generating the near-optimal code sequence.*

Thus all remaining dependent claims 37, 38, and 42 are also allowed.

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Claim 39:

Prior art of record taken either singly and/or in combination, does not teach or disclose a code sequence generation tool executable on a computer as recited in independent claim 39 with the following features:

An input capable of receiving a multi-assignment; matching means responsive to the multi-assignment and producing, via matching of the multi-assignment and facts regarding operators computable in the computer, a number of possible plans for creating the near-optimal code sequence; *planning means configured to select via a satisfiability search an optimal plan from among the possible plans produced by the matching means, the optimal plan corresponding to the near-optimal code sequence; wherein the code sequence generation tool is configured to invoke the matching means and the planning means thereby implementing automatic theorem-proving for automatically generating the near-optimal code sequence.*

Thus the remaining dependent claim 43 is also allowed.

Claim 44:

Prior art of record taken either singly and/or in combination, does not teach or disclose a method executable on a computer as recited in independent claim 44 with the following features:

Inputting, to a code sequence generator, expressions corresponding to a fragment of program code; generating, by the code sequence generator based on the input expressions and facts regarding operators computable in a computer, a data structure representing plural ways of computing the input expressions; *then performing a satisfiability search by the code sequence generator to select one of the ways as an optimal solution associated with a minimum machine cycle budget, the optimal solution corresponding to the near-optimal code sequence.*

Thus the remaining dependent claim 45 is also allowed.

Claim 46:

Prior art of record taken either singly and/or in combination, does not teach or disclose a computer-readable medium embodying code as recited in independent claim 46 with the following features:

Inputting, to a code sequence generator, expressions corresponding to a fragment of program code; generating, by the code sequence generator based on the input expressions and facts regarding operators computable in a computer, a data structure representing plural ways of computing the input expressions; *then performing a satisfiability search by the code sequence generator to select one of the ways as an optimal solution associated with a minimum machine cycle budget, the optimal solution corresponding to the near-optimal code sequence.*

Thus the remaining dependent claim 47 is also allowed.

4. The closest prior art is Garland et al., U.S. Patent 6,289,502:

Garland discloses that before automatic translation or code generation, the specification that results form a final manual translation step can be used as an input to validation tools, such as a theorem prover, model checker, or simulator, in addition to as input to translation or code generation tools which produce software in computer programming languages which can be interpreted, executed directly, or compiled to executable forms. However, it does not disclose applying technologies that would be normally in automatic theorem proving to the problem of automatically generating the code. The aspect of the automatic theorem proving is realized in

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the present application by matching followed by planning with a satisfiability search in order to generate the optimal code sequence.

Conclusion

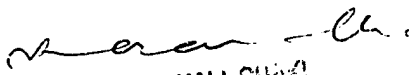
5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lawrence Shrader whose telephone number is (571) 272-3734. The examiner can normally be reached on M-F 08:00-16:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kakali Chaki can be reached on (571) 272-3719. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Lawrence Shrader
Examiner
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5 October 2005


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